AMENDMENTS TO THE SPECIFICATION:

Page 1, amend paragraph [0001] as:

[0001] The present invention relates to dual inertial sensors made with micro-machining technology, including both functions of a gyroscope (angular rate sensor) and an accelerometer (acceleration sensor), and more particularly to [[a]] dual inertial sensors made with bulk-micromachining and wet etching on (110) silicon chips.

Pages 1-2, amend paragraph [0002] as:

[0002] A conventional structure of dual inertial sensors made with bulk-micromachining is shown in figure 1. It is made of (100) silicon chips 1, comprising an outer frame 2. The outer frame 2 comprises one or more inner frame 5, and each inner frame 5 is further comprising a proof-mass 3. The proof-mass 3 is connected to the inner frame 5 by a plurality of sensing flexible beams 4, and the inner frame 5 is connected to the outer frame 2 by a plurality of driving flexible beams 6. The sensing beams 4 facilitate the proof-mass 3 to move perpendicular to the surface of the silicon chip (defined as z-direction), and the driving beams 6 facilitate the proof-mass 3 to move in parallel to the surface of the silicon chip (defined as y-direction). Two glass sheets ~~71, 72~~ (not shown in figure 1) are placed on both sides of the silicon chip 1, and connected to the outer frame 2. The thin metal film electrodes 81, 82 are electro-plated on the glass sheets ~~71, 72~~ facing the silicon chip surface and corresponding to the two edges of the inner frame 5, respectively. The two thin metal film electrodes 81, 82, with the surface of the inner frame 5, will form edge effect electrostatic driving capacitors c8p, c8n. A thin metal

film electrode 9 is electrode-plated on the glass sheets ~~71, 72~~ facing the silicon chip surface and the proof-mass 3. The thin metal film electrodes 9, with the surfaces of the proof-mass 3, will form two sensing capacitors c9p, c9n. The alternating driving voltage on the driving capacitors c8p, c8n will make the inner frame 5 and the proof-mass 3 [[to]] vibrate along y-axis. If there is an angular velocity Ω along x-axis, there will be a Coriolis force F making the proof-mass 3 vibrate along z-axis. The angular rate can be obtained by measuring the amplitude of the z-direction vibration of the proof-mass 3. If there is an acceleration applied along the z-axis, the specific force will move the proof-mass 3 with respect to the inner frame. The acceleration can be obtained by measuring the displacement made by the movement of proof-mass with respect to the inner frame. When the proof-mass 3 [[move]] moves, the capacitances of the sensing capacitors c9p, c9n will change due to the changes in the capacitor's gap. The displacement of the proof-mass can be obtained by measuring the difference of the capacitances of the capacitors c9p, c9n. As the output signal generated by the angular rate is an alternating signal, and the output signal generated by the acceleration is a low frequency or direct current signal, a signal processing method can be applied to separate the angular rate signal from the acceleration signal.

Pages 2-3, amend paragraph [0004] as:

[0004] The major drawback of the aforementioned sensors is in the manufacturing process of the driving beams. As shown in figure 2, the etching is first applied on both sides of the silicon chip. As the speed of silicon wet etching is related to the lattice direction, the etching is slowest along the <111> direction. It is virtually impossible to

etch along this direction. Hence, the initial stage of the etching would be as shown in figure 2(a). The slant lines represent the (111) facets. If the etching continues, it will proceed ~~proceeds~~ along the <110> direction from the intersection of two (111) facets, as shown in figure 2(b). Figures 2(c)-2(e) show the side views of different stages when ~~etching~~ both sides of the driving beam are etched. When the etching is perpendicular to the surface, the process should stop and the silicon chips should be removed from the etching solution. However, as there is no automatic mechanism to stop the etching as in the (111) facet, it is hard to control the width of the driving beam. The width of the driving beam affects the coefficient of elasticity, which in turn will affect the resonance frequency. If the width of the driving beam is not accurate, the resonance frequency will be different from that of the sensing beams, and deviate ~~deviates~~ from the original design. For vibration systems with larger Q values, the tolerance of the deviation is smaller. This poses a major problem for the quality of the products.

Page 3, amend paragraph [0005] as:

[0005] The major features of the present invention are: (1) dual inertial sensors made by etching (110) silicon chip whose width can be accurately controlled during the etching process; (2) the design to reduce the air damping of the (110) silicon proof-mass; (3) preventing the proof-mass from sticking to glass sheets; and (4) built-in temperature sensing capacitors placed in the chip area unaffected by the inertial force, and compensating the temperature error in the dual inertial sensors by direct measurement of the temperature changes in the chip.

Pages 3-4, amend paragraph [0007] as:

[0007] Figure 1 shows the top view of a dual inertial sensor ~~sensors~~ in related arts.

Figure 2 shows the etching process of the driving-beam on a (100) silicon chip in related arts.

Figure 3 shows the top view of a dual inertial sensor ~~sensors~~ made with a (110) silicon chip in accordance with the present invention.

Figure 4a shows the top view of the structure of an integrated driver.

Figure 4b shows stripe electrodes of the driver on the glass sheet surface and their bond pads.

Figure 4c shows the cross-section view of the structure of an integrated driver.

Figure 5a shows the top view of the structure of the (110) [[Si]] silicon chip of the preferred embodiment of the present invention.

Figure 5b shows the driving stripe electrode ~~electrodes~~ pair, sensing electrodes and their bond pads on the glass sheets ~~glasses~~ of the preferred embodiment of the present invention.

Figure 6 shows the design of stickiness prevention and the design of reducing air damping on the proof-mass.

Page 4, amend paragraph [0008] as:

[0008] Figure 3 shows the top view of a dual inertial sensor ~~sensors~~ in accordance with the present invention. Its structure is made by wet etching a (110) silicon chip 11. It

is shaped as a parallelogram, instead of a rectangular shown in figure 1. The sides of all the components are in parallel with the intersection line of the (110) silicon chip surface and the silicon lattice {1-1-1} facet or {1-11} facet. Any two sides form an angle of 109.48°or 70.52°; hence most of the components are shaped as parallelograms. Because the two {111} facets, namely {1-1-1} and {1-11}, of the (110) silicon chip are perpendicular to the {110} facet, and conventional KOH and EDP etching solutions etch {111} facet much slower than {100} or {110} facets, ~~therefore,~~ a vertical surface can be obtained by keeping the protective mask aligned with the intersection line of the (110) silicon chip surface and the {1-1-1} facet or the {1-11} facet during the etching process. In this embodiment, the structure comprises an outer frame 2. Inside the outer frame 2 there is ~~comprises~~ an inner frame 5, and the inner frame 5 [[is]] further comprises ~~comprising of~~ a proof-mass 3. The proof-mass 3 is connected to the inner frame 5 by a plurality of sensing resilient ~~flexible~~ beams 4, and the inner frame 5 is connected to the outer frame 2 by a plurality of driving resilient ~~flexible~~ beams 6. The sensing resilient ~~flexible~~ beams 4 facilitate the proof-mass 3 to move perpendicular to the surface of the silicon chip (defined as z-direction), and the driving resilient ~~flexible~~ beams 6 facilitate the inner frame 5 and the proof-mass 3 to move in parallel to the surface of the silicon chip (defined as y-direction). Two glass sheets 71, 72 (not shown in figure 3) are placed on both sides of the silicon chip 11, and connected to the outer frame 2. The thin metal film electrodes 81, 82 are electro-plated on the two glass sheets 71, 72 facing the silicon chip surface and the inner frame 5. The two thin metal film electrodes 81, 82 of each glass sheet, with the corresponding surface of inner frame 5, will form edge effect

electrostatic driving capacitors c8p, c8n. A thin metal film electrode 9 is electrode-plated on the glass sheets 71, 72 facing the proof-mass 3. The thin metal film electrodes 9, with the surfaces of the proof-mass 3, will form two sensing capacitors c9p, c9n. The alternating driving voltage on the driving capacitors c8p, c8n will make the inner frame 5 and the proof-mass 3 [[to]] vibrate along y-axis. If there is an angular velocity Ω along x-axis, there will be a Coriolis force F making the proof-mass 3 vibrate along z-axis. The angular rate can be obtained by measuring the amplitude of the z-direction vibration of the proof-mass 3. If there is an acceleration applied along the z-axis, the specific force will move the proof-mass 3 with respect to the inner frame. The acceleration can be obtained by measuring the displacement made by the movement of the proof-mass with respect to the inner frame. When the proof-mass 3 moves, the capacitances of the sensing capacitors c9p, c9n will change due to the changes in the distance. The displacement of the proof-mass can be obtained by measuring the difference of the capacitances of the sensing capacitors c9p, c9n. As the output signal generated by the angular rate is an alternating signal, and the output signal generated by the acceleration is a low frequency or direct current signal, a signal processing method can be applied to separate the angular rate signal from the acceleration signal.

Page 6, amend paragraph [0011] as:

[0011] Figure 5a shows a preferred embodiment of a silicon dual inertial sensor ~~sensors~~ of the present invention. ~~By combining a and b as the structure shown in figure 3, the structure~~ The silicon dual inertial sensor comprises two structures shown in figure 3 and is also made by wet etching on a (110) silicon chip 11. This embodiment comprises

an outer frame 2, which [[is]] further comprises ~~comprising~~ two inner frames 5a, 5b, a central anchor 21, and a plurality of connecting ~~masses~~ blocks 22. The inner frames 5a, 5b have [[a]] proof masses ~~mass~~ 3a, 3b, respectively, which [[is]] are connected to the corresponding inner frame by at least a sensing resilient beam 4. Each inner frame is connected to two common connecting beams 61 by at least a driving resilient beam 6, and then connected to the central anchor 21 by the common resilient supporting beam 60. Each surface of the silicon chip, with the exception of the areas of the outer frame 2, the central anchor 21 and the connecting ~~masses~~ blocks 22, is etched for about 3um. The sensing beams make it easier for the proof-masses 3a, 3b to move perpendicularly to the surface of the silicon chip (the z-axis), and the driving beams make it easier for the inner frames 5a, 5b to move along one of the directions of the surface of the silicon chip (the y-axis). The two sides 51, 52, perpendicular to the y-axis, of the inner frames are the driving bodies, and each surface comprises a plurality of long trenches or slits 5t, perpendicular to the y-axis.

Page 7, amend paragraph [0012] as:

[0012] Two glass sheets 71, 72 are placed on the front side and the back side of the silicon chip 11, respectively. The glass sheets 71, 72 are combined with the outer frame 2, the central anchor 21 and the connecting mass 22. The surface of each glass sheet facing the corresponding driving body 51 has two sets of long electrodes 81, 82, which interpose each other, and are parallel to the long trenches or slits 5t and connected to bond [[pad]] pads 81p and 81n, respectively, as shown in figure 4.b. The relative position between long trenches or slits 5t on the driving body 51, and its corresponding long

electrodes 81, 82 is shown in the cross-sectional view in figure 4.c. Two driving capacitors c81p, c81n are formed. Similarly, the surface of each glass sheet facing the corresponding driving body 52 has two sets of long electrodes 81, 82, which interpose each other, and are parallel to the long trenches or slits 5t and connected to bond pads 82p and 82n, respectively. Each surface of each driving body 52 and its corresponding long electrodes 81, 82 also form two driving capacitors c82p, c82n.

Page 7, amend paragraph [0013] as:

[0013] The surfaces of the glass sheets 71, 72 facing the surfaces of each proof-mass are electroplated with [[a]] metal thin film electrodes 9, which are connected to bond pads 9p, 9n, respectively, and form sensing capacitors c9p, c9n with the surfaces of each proof-mass.

Pages 7-8, amend paragraph [0014] as:

[0014] By adjusting the phase of the external alternating voltages on the driving capacitors, it is possible to make the ~~proof-mass~~ proof-masses 3a, 3b move in the opposite directions ~~direction~~ of y-axis. If there is a rotating angular speed Ω in the x-axis direction, there will be a Coriolis force to move ~~proof-mass~~ the proof-masses 3a, 3b in the opposite directions ~~direction~~ of z-axis. If an acceleration is input along the z-axis, the specific force will move the ~~proof-mass~~ proof-masses 3a, 3b along the z-axis. When the ~~proof-mass~~ proof-masses 3a, 3b move, the capacitance of the sensing capacitors c9p, c9n formed by the ~~proof-mass~~ proof-masses and the metal thin film electrodes 9 on the glass sheets 71, 72 will change due to the distance change. The displacement (distance) of the

~~proof-mass~~ proof-masses 3a, 3b can be calculated by measuring the capacitance difference between the sensing capacitors c9p, c9n. The output signal from the rotation rate is an alternating signal, and the output signal from the acceleration is a direct signal. These two signals can be separated by signal processing technology. The electrodes 9 of the sensing capacitors c9p, c9n can also be partitioned, as shown in figure 5b, into a feedback electrode 9f, and its bond pad 9fb for the gyroscope to rebalance the Coriolis force.

Page 8, amend paragraph [0016] as:

[0016] To avoid the stickiness problem in the process of bonding the silicon chip and the glass sheets, a plurality of small bumps ~~or convex~~ 3s and its insulation layer 3i can be provided on the surface of the proof-mass 3 for ~~separator~~ separation, as shown in figure 6.

Page 8, amend paragraph [0017] as:

[0017] To enhance the bonding force between the silicon chip and the glass sheets, the ~~non-specific~~ part of the silicon chip[[,]] which does not interfere with the movement of components should be kept[[,]] as the connecting block 22 in figure 5.a[[,]] to attach to the glass sheets.

Page 8, amend paragraph [0018] as:

[0018] To eliminate the impact of temperature on the output signals, and to improve the performance of the gyroscope and accelerometers, a small recessed area ~~concave~~ TS1 can be etched on the surfaces of the outer frame 2, the central anchor 21, or the connecting blocks ~~block~~ 22. A metal thin film electrode TS2 is electroplated on the

corresponding surface of the glass sheet, and connected to the bond pad TS to form a capacitor cTS for sensing temperature. Because it is affected by neither the rotation rate nor the acceleration, and only affected by the temperature, it can be used to compensate for the impact of the temperature on the capacitors c9p, c9n, which are for sensing the inertial force.

Page 8, amend paragraph [0019] as:

[0019] As shown in figure 5.a, because the silicon chip is electrically conductive, a small recessed ~~concave~~ slit st must be etched on the surfaces of the outer frame 2, where the thin film metal wire passes, in order to avoid short circuit.

Page 9, amend paragraph [0020] as:

[0020] Based on the design of the two embodiments, there can be many different ~~design and combination~~ designs and combinations. For example, the capacitor gap between the proof-mass and the two glass sheets can be replaced by recessed areas ~~concaves~~ etched on the surface of the glass sheets. The layout of the resilient beams can also be varied, for example, the driving resilient beam 6 of the inner frame can also be connected to the outer frame 2.

Page 9, amend paragraph [0021] as:

[0021] In summary, the present invention discloses ~~disclosed~~ a dual inertial sensor ~~sensors~~ made of a (110) silicon chip with vertical deep etching. The width of driving beam and the driving resonance frequency can be precisely controlled to improve the yield rate and the performance of the gyroscope. It also provides the other features: a

design to reduce air resistance to improve the resonance amplification ratio of the sensing axis; a design for preventing the stickiness problem between the proof-mass and the glass sheets; and at least a built-in temperature sensing capacitor for real time measurement of temperature change in the chip to improve the temperature effect of the dual inertial sensors.